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of

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for a

METHOD FOR FILLING A CONTAINER WITH A LIQUID OR POURABLE SUBSTANCE

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BACKGROUND OF THE INVENTION

Field of the Invention

[0001] This invention relates to a method for dispensing a defined minimum quantity of a liquid or pourable substance into a container, in the process of which the amount of the substance dispensed is measured and a valve closes to terminate the filling process as soon as the amount delivered has reached a specific final value.

[0002] In the production and distribution of liquid or pourable substances such as beverages, the filling of these substances into containers, for instance bottles, plays a significant economic role. Typically, the substance is dispensed by a large filling and packaging system such as a rotary bottling machine, for instance with 150 bottling stations that permit the simultaneous filling of 150 bottles. A rotary bottling system of that type is capable of filling up to 70,000 bottles per hour, each holding one liter of the beverage concerned. Overfilling each bottle with only 5 milliliters of beverage adds up to an error amount of 350 L per hour, 850 L per day and about 250,000 L per month. Hence, for cost reasons alone, accurately quantized dispensing of the beverage is highly desirable.

Background Information

[0003] In prior-art packaging systems, the filling of the containers with the substance concerned typically involves the following steps. The substance is delivered from a storage tank through a valve into a container, with the quantity of the substance delivered to the container, typically its volume or weight, being measured by means of a mass or volume flowmeter. As soon as the dispensed amount of the substance thus measured has reached a setpoint value, hereinafter referred to as the final value, the valve closes, terminating the filling process.

[0004] The closing of the valve, however, takes a finite length of time as a result of which, after the predefined setpoint value is reached, an additional amount of the substance is delivered into the container, a phenomenon referred to as tailing. Such tailing is also attributable to the fact that the valve, being a mechanical component, and the valve-controlling device activating the valve, are subject to response and dead times. As a rule, then, the amount of substance dispensed into the container exceeds the final value at which the closing of the valve is to terminate the filling process.

[0005] In prior-art packaging methodology, this problem is often addressed by measuring for each container filling the tailing amount and comparing it with the minimum amount that should be dispensed into the container. The difference between the measured actual amount and the setpoint minimum amount, constituting the tailing, is deducted from the nominal quantity in subsequent filling processes either in stepwise fashion, i.e. only by a certain percentage at a time, or by establishing a floating mean value from the tailing values of several consecutive measurements. The actual amount dispensed into the container concerned is thus reduced, approaching the targeted minimum amount over the course of several consecutive filling cycles. An immediate, complete adjustment in the second filling cycle for the tailing measured in the first cycle is not possible, given that such compensation would be subject to unstable fluctuation.

[0006] It is in particular at the time of the startup of a filling system, for instance on changeover to a new substance, or after cleaning or after being reset for a different container capacity, that the initial quantities dispensed are quite inaccurate, so that the amounts filled into the containers often exceed established tolerances. Taking for instance a large rotary bottling system with 150 bottling stations, any startup of the system can result in as many as 1,000 improperly filled and thus partly unsaleable bottles.

SUMMARY OF THE INVENTION

[0007] It is, therefore, the objective of this invention to introduce a method for filling a liquid or pourable substance into a container, offering improved dispensing accuracy especially upon startup of the decanting and packaging system used in applying this dispensing method.

[0008] According to this invention, that objective is achieved by filling the substance into a first container in several dispensing steps whereby, after a first dispensing step, the valve is closed to interrupt the filling process, allowing the determination of the tailing of the substance that occurs during the closing of the valve, followed as the next step by the opening of the valve to resume the filling process, at which juncture the final value for terminating the subsequent dispensing step is established, factoring-in the tailing of the substance as determined in a preceding dispensing step during the closing of the valve.

[0009] In other words, especially for the startup of the system used in applying this filling method, the invention provides for the dispensing of the substance into the first container not in one continuous step but in at least two discrete steps, whereby the filling of the first container is interrupted at least once by closing the valve, thus allowing the tailing to be quantified. The tailing factor determined in this fashion can already be used in the filling of the first container, allowing the final value for terminating the filling of the first container to be established in a manner as to keep the filling of that container within permissible tolerances.

[0010] It is entirely possible to apply the method according to this invention using only two mutually different dispensing steps for filling the container. However, a preferred version of the invention provides for the first dispensing step to be followed by multiple consecutive dispensing steps, involving the determination of each individual final value for terminating the respective subsequent dispensing step after factoring-in the tailing of the substance as determined in the respective preceding dispensing step during the closing of the valve. An appropriately large number of consecutive dispensing steps following the initial dispensing step permits the determination of a corresponding number of tailing values, and especially a sufficient number of tailing values whereby in any event the final value for terminating the last dispensing step for filling the container can be achieved within predefined tolerances.

[0011] In a preferred implementation of the invention, the final value for terminating the last dispensing step in filling the container is determined by compensating for the tailing of the substance determined in the preceding dispensing step during the closing of the valve in due consideration of the intended minimum substance amount. In another preferred implementation of the invention, the final value for terminating the last dispensing step in filling the container is established in consideration of the minimum amount of substance and of a number, or preferably all, of the substance tailings determined in the preceding dispensing steps during the closing of the valve. As a particular feature, the substance tailing values determined in the preceding dispensing steps during the closing of the valve are averaged to establish the final value for terminating the last dispensing step.

[0012] In another preferred embodiment of the invention, the filling of the first container is followed by the filling of another container in a single dispensing step, in which case the final value for terminating that single dispensing step in filling that additional container is established in consideration of the desired minimum substance amount and of a tailing value determined during the filling of the first container. In contrast to the prior

art systems wherein an adequate number of tailing values cannot be obtained until several containers have been sequentially filled, it is possible in this case to obtain a sufficient number of tailing values already as soon as the first container has been filled, whereupon additional containers can be filled in one continuous dispensing cycle. The final value is established simply by applying a tailing value that was determined during the filling of the first container.

[0013] As a special feature in a preferred embodiment of the invention applying the above-described procedure, the final value for terminating the single dispensing step for filling the additional container is established by averaging the tailing values determined during the filling of the first container. Moreover, in a preferred version of the invention, the filling of the first container is followed by the individual filling of multiple additional containers, in which case the respective final value terminating each such filling is established in consideration of the minimum substance amount and of a tailing value determined in a preceding filling process. In particular, this may include an operation whereby, in the *n*th step, the final value E_n is established as follows:

$$E_n = E_{n-1} - \sum_{i=n-x}^{n-1} \frac{Ni}{x}$$

where N is the tailing and x is the number of filling processes in which the tailing values are used for establishing the final value.

[0014] There are numerous ways in which the method according to this invention can be configured and expanded. In that context, attention is invited to the dependent claims and to the following detailed description of a preferred embodiment of the invention with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] In the drawings:

FIG. 1 is a schematic illustration of a bottling process according to a preferred embodiment of the invention, employing an appropriate dispensing system;

FIG. 2 is a diagrammatic representation of the progression of a conventional filling process;

FIG. 3 is a diagrammatic representation of the progression of a process according to a preferred embodiment of the invention as compared to a conventional process, and

FIG. 4 is a plot of the dispensed quantities in the case of consecutive fillings with conventional and, respectively, novel compensation for tailing, according to a preferred embodiment of the invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0016] FIG. 1 illustrates schematically the dispensing of a substance 1 into a container 2 using a dispensing system 3. The substance 1 may be a liquid or a pourable bulk product. In the case shown, it is a beverage. The dispensing system 3 includes a reservoir 4, a flow-measuring device 5 and a valve 6. When the valve 6 is open, the substance 1 flows into the container 2.

[0017] The valve 6 is controlled, i.e. opened and closed, by a valve controller 7. The valve controller 7 is also connected to the flow-measuring device 5, which permits operation of the valve 6 as a function of the dispensed amount of substance 1 as detected by the flow-measuring device 5.

[0018] The flow-measuring device 5 may be in the form of a mass flowmeter or a volume flowmeter such as a magnetoinductive flowmeter or an ultrasound flowmeter. The flowmeter 5 signals the flow volume detected by it to the valve controller 7, in the case of the preferred embodiment of the invention here illustrated in FIG. 1 in the form of scaled pulses, specifically one pulse per predefined quantity unit detected. Alternatively, the information on the flow amount detected by the flowmeter 5 may be transmitted to the valve controller 7, for instance, in the form of a digital signal via a bus interface.

[0019] The valve controller 7 integrates the flow-volume data collected by and received from the flowmeter 5. The integrated flow data reflect at all times the amount of substance that has been dispensed from the reservoir 4 through the flowmeter 5 and the valve 6 into the container 2.

[0020] FIG. 2 is a diagrammatic illustration of the filling of the container 2 with the substance 1 by a conventional process, manifesting the tailing-related problem associated with the time it takes to ultimately close the valve 6. At point t_0 the valve controller 7 opens the valve 6. As indicated in FIG. 2, the flow rate, shown as the hatched area in the diagram, almost immediately rises to a constant level, here calibrated at a value of 1. Consequently, as time progresses, the amount of substance 1 dispensed into the container 2 will increase, as represented by the straight, linearly sloped line. At point in time t_1 the amount of substance 1 dispensed into the container 2 reaches the final value E of 100, which, due to the integration of the flow data for the dispensed amount of substance 1 by the flowmeter 5, prompts the valve controller 7 to close the valve 6. In the case at hand, the final value of 100 constitutes the targeted minimum amount, meaning that in this case the minimum amount of 100 is to be dispensed into the container 2, so that for the time being the filling process is not terminated before that value is reached.

[0021] By the time the valve 6 is closed, a finite time span will have elapsed from point t_1 forward, meaning that the flow will not stop until later, at point t_2. While the valve 6 proceeds to close, the flow remains nearly constant as illustrated in FIG. 2, the result being that the container 2 receives a quantity of substance 1 that exceeds, by the amount of the tailing N, the final value E of 100 at which the valve controller 7 was to close the valve 6.

[0022] In FIG. 3, the bottom waveform reflecting the method according to the preferred embodiment of the invention, shows that, in contrast to the conventional method represented by the top waveform, the flow is interrupted several times during the process of filling the container 2 with the substance 1 before the minimum amount of the substance to be dispensed into the container 2 is reached, in this case three times at points a, b and c. In the plot according to FIG. 4 reflecting the individually dispensed amounts in the first filling process, these interruptions that take place before termination of that first filling process have been extrapolated to a complete filling. At interruption point *a*, prompted by the valve controller 7 triggering the valve 6 at one fourth of the final value of 1000, i.e. at 250, the valve 6 had closed completely after a dispensed amount of 255. The tailing thus amounted to 5, so that, if the system were shut off at an end value of 1000, the actual amount would have been 1005.

[0023] Based on that information relative to the tailing delay of the valve 6 as demonstrated in the preferred embodiment of the invention illustrated, the valve 6 will be actuated that much earlier at interruption points b and c, below an extrapolated minimum value of 1000, so that, with an appropriate setting of the final value for terminating the last dispensing step, the valve 6 is triggered early enough to cause the amount of substance 1 that is actually dispensed into the container 2 to be above the required minimum value of 1000 and below 1002, and thus within the setpoint tolerance of 2. By additionally applying, for instance, the equation shown above for the final value E, it is actually

possible in subsequent filling processes to further reduce the amount of substance 1 dispensed into the container 2, bringing it close to the desired minimum value of 1000.

[0024] It bears mentioning that, of course, with a fixed setpoint number of interruptions during the first filling process, it is possible for the amount of substance 1 dispensed into the container 2 in that first filling process to exceed the tolerance limit of 1002. In that case, the procedure described in the preferred embodiment of the invention can be further enhanced by means of interruptions in the second filling step as well, bringing the actual amount of substance 1 dispensed to within the tolerance range.

What is claimed is: